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The Effect of Nitrogen Fertilization Rates on Head Lettuce Yields: A Preliminary Report

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INTRODUCTION

Quantities of nitrogen (N) traditionally applied to lettuce fields by commercial growers range from lows of 80 to 120 lbs N/A (commonly 800 to 1200 lbs of 8-32-16 or 10-20-20) to rates as high as 250 lbs N/A. The higher rates are attained by supplementing the principal application of N-P-K with ammonium nitrate. Fertilization response research conducted elsewhere suggests that the higher rates are well beyond quantities of N required for maximum yields; however grower experience indicates that the additional N indeed does increase head size and yields, especially in late season plantings when cooler soil temperatures may reduce N uptake. Optimal rates of N to be applied can differ depending upon application rate during the previous year and carryover of N in the soil. Questions remain as to what soil N concentration is required for optimal yield under Alaskan conditions.

The field experiment reported here was conducted to assess the effects of increasing rates of N fertilization on lettuce yields and soil N concentrations. Although preliminary, these data may be helpful to growers deciding N application rates.

MATERIALS AND METHODS

The experiment was conducted on the Agricultural and Forestry Experiment Station Matanuska Research Farm near Palmer, Alaska. The field site chosen had a recent history of grain production. Fertilization rates had been low compared to vegetable crop requirements, and thus the concentration of residual N in the soil was low. Plots were plowed and disked prior to fertilization. Phosphorus (384 lbs/A P_20_5) and potassium (192 lbs/A K_20) were applied uniformly over the entire plot area. Nitrogen (NH_4N0_3) was applied to individual plots at one of seven rates: 0, 25, 50, 100, 150, 200 or 250 lbs N/A. Immediately after application, fertilizers were tilled into the top 4-6 inches, followed by packing of the soil.

Lettuce (*Lactuca sativa* L. var Salinas) was both seeded and transplanted on each of three dates: May 8 (early), June 5 (midseason) and June 25 (late). Pelleted seeds were planted with a hand-operated seed drill, and transplants (28-day-old-greenhouse grown plugs) were planted by hand. Transplants were placed 11 inches apart in rows spaced 18 inches apart. Seeded plots were thinned to a similar stand at the appropriate time. Twenty heads were harvested from the center of each plot when mature. Treatments were arranged in a randomized complete block design with four replications.

Soil N concentrations were determined on samples collected biweekly from the top 6 inches of soil in each plot. Soil was air dried, sieved through a 2-mm mesh screen, then N was extracted in 2N KCl. Also, samples were collected to a depth of 15 inches, from the 250 lb N/A plots only, on three occasions: prior to fertilization, midseason, and after harvesting. The 15-inch cores were divided into five segments of equal size, and each was analyzed separately. Deep samples were utilized to determine the location and concentration of N at various depths.

RESULTS

Comparative yields, expressed in average head weights, are summarized in Figure 1. Per acre yields may be calculated from head weights, but yield response curves would be similar to those in Figure 1. Yields generally increased with increasing quantities of applied N up to 100 lbs/A; above 100 lbs N/A there was little or no yield increase. This trend was observed with all seeded and transplanted treatments. (Note: A failure of the irrigation system in the early part of the summer resulted in loss of the midseason seeded treatments and reduced yields in the early transplant treatments.)

Nitrogen determinations (NH_4 plus $N0_3$-N) on samples collected from the top 6 inches are summarized in Figure 2. Data were collected from seeded and transplanted plots at each planting; all showed similar trends but only one (the midseason transplanted treatment) is presented here. These results indicate changes in soil N due to rates of N application and rainfall. Increasing rates of N application generally resulted in increased quantities of extractable N. Samples from plots fertilized with 0, 25, or 50 lbs N/A contained less than 50 parts per million (ppm) N, while plots fertilized with 100 or more lbs N/A were generally above and frequently far above the 50 ppm concentration. Concentrations of extractable N in the top 6 inches of plots fertilized with 100 lbs N/A or more remained high until a period of heavy rainfall, during which 3 inches fell in two weeks (figure 2). Levels of extractable N in the top 6 inches of soil declined sharply during the high rainfall period, probably due to leaching of N to lower levels in the soil.

Results of deep sampling are summarized in Figure 3. Again, sampling was carried out at all three planting dates for seeded and transplanted plots. All showed similar trends and the early transplant treatment is presented to illustrate these trends. Very low N concentrations were present in the soil prior to fertilization. Forty-three days after fertilizer application, most of the soil N was located in the top 6 inches of soil. Post-harvest samples (106 days after fertilization) revealed low N concentrations in the top 6 inches with the bulk of residual N found between 6 and 15 inches.

DISCUSSION

Data summarized in Figure 1 indicate that maximum lettuce yields were obtained when N was applied at 100 lbs per A. This finding is consistent with N application rates traditionally used by Matanuska Valley lettuce growers. Higher rates of N application did not result in increased head weight in this study, even on lettuce seeded and harvested late in the season.

Residual soil N was very low prior to fertilization, and plots receiving no N did not produce marketable heads. Head size in plots receiving 25 or 50 lbs N/A also were generally too small for marketing. It is expected that soils with medium to high levels of residual N, such as one may find in fields regularly fertilized for vegetables, may require less applied N to attain marketable head size than would fields of the type used in this experiment. If residual N is present, maximum yields may be obtained with less applied N.

Nitrogen is a mobile element, and will move rapidly down through the soil profile with excess water. This is illustrated in Figure 2 where extractable N levels dropped precipitously during and after a period of high rainfall. If one is anticipating high levels of residual N in a soil as a result of previous year's application, it would be well to consider the previous years rainfall. If rainfall had been heavy, much of the N that ordinarily would remain may have leached through the soil profile and be lost. Late fall and early spring soil tests to a depth of 12 to 15 inches will help to determine the location and concentration of residual N.

Late-season sampling of these plots indicated the bulk of residual soil N was below 6 inches in depth. A portion of this N may migrate upward in the spring during the dry periods that generally occur during the months of April and May. However, heavy early season rainfall or irrigation will impede this upward movement and delay or prevent utilization by the plants, depending on how far into the soil profile root development continues. Additional studies are required to assess the availability of residual N in the subsoil.

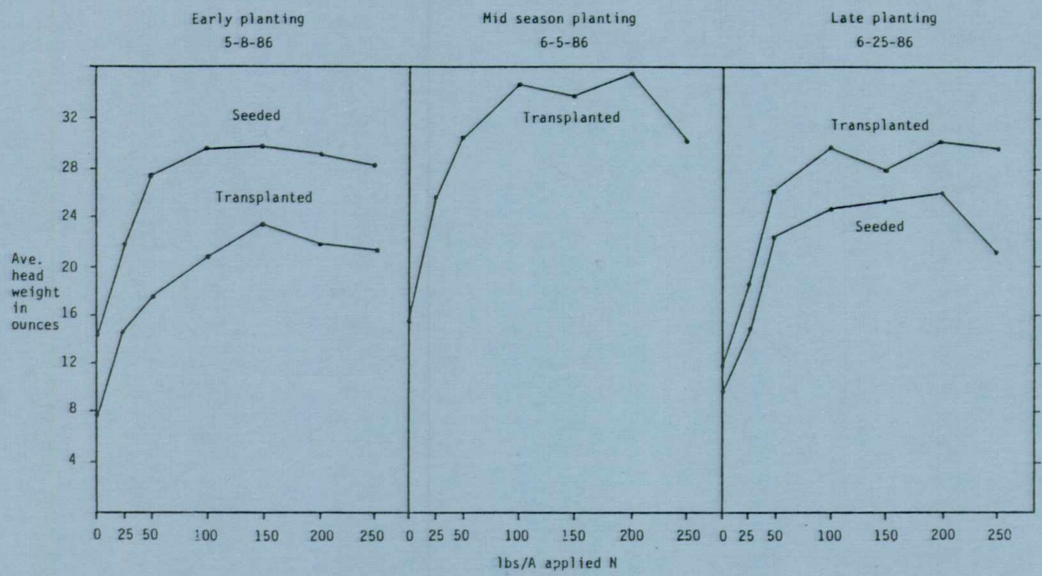

Figure 1. Comparative yields of seeded and transplanted lettuce from early, mid- and late-season plantings.

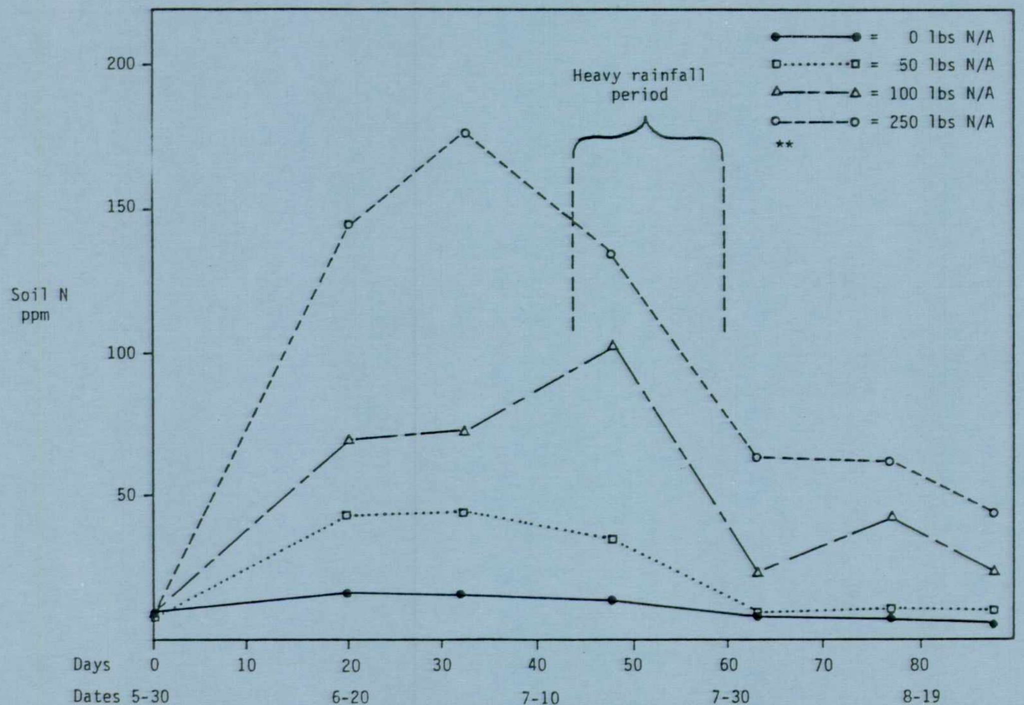

Figure 2. Quantities of N in the top 6 inches of soil at various times during the season.*

*These data are from mid season transplanted plots. Early, mid and late season seeded and transplanted plots all showed similar trends. Soil N includes NH_4 and NO_3-N.

**For the sake of clarity, three rates of application (25, 150, 200) are not included.

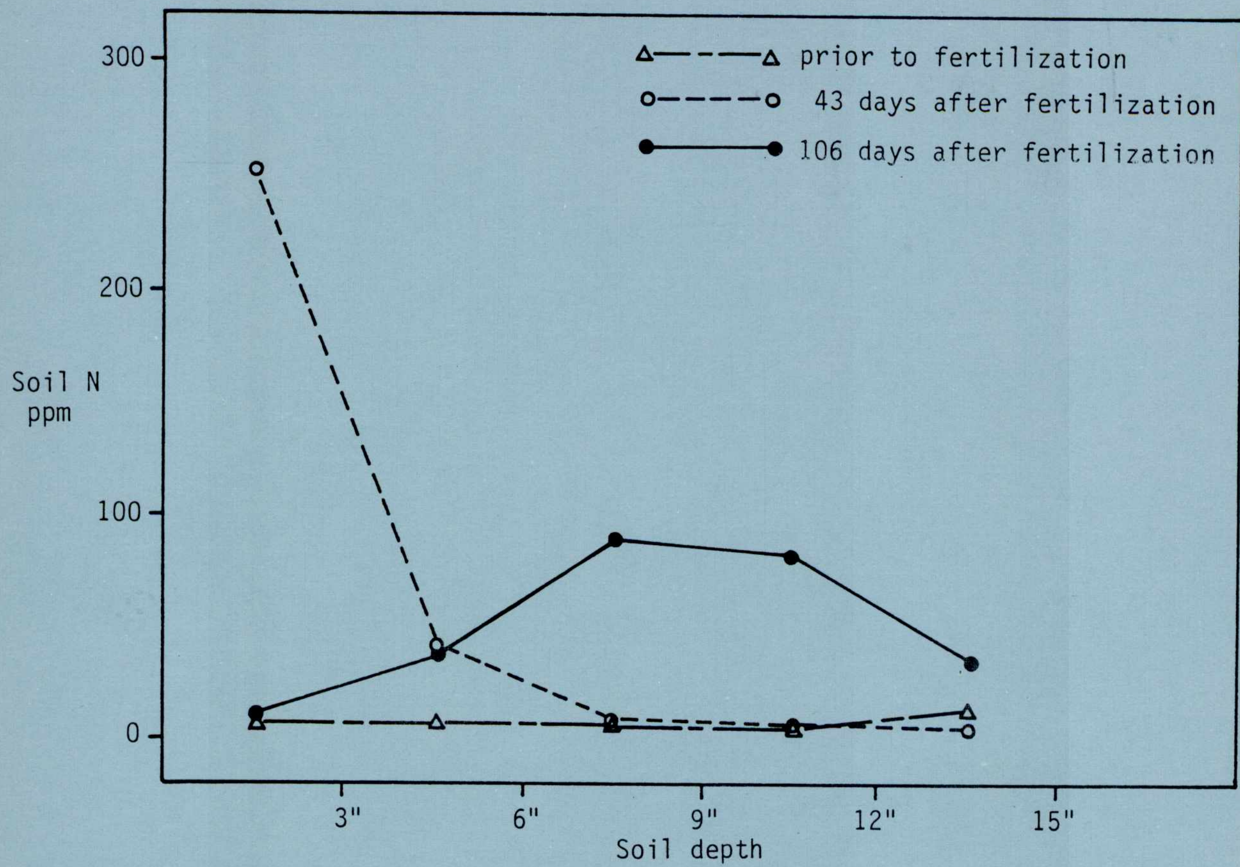

Figure 3. Quantity and location of residual soil N at various times during the season.*

*These data are from early seeded plots that receive 250 lbs N/A. Early, mid- and late-season seeded and transplanted plots all showed similar trends. Soil N includes NH_4 and NO_3-N.

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